

Land Atmospheres Near-real-time Capability for EOS (LANCE) User Working Group Meeting Summary

Kevin Murphy, NASA Goddard Space Flight Center, kevin.e.murphy@nasa.gov

Chris Justice, University of Maryland, justice@hermes.geog.umd.edu

Michael Teague, NASA Goddard Space Flight Center, michael.j.teague@nasa.gov

Karen Michael, NASA Goddard Space Flight Center, karen.a.michael@nasa.gov

Dawn Lowe, NASA Goddard Space Flight Center, dawn.r.lowe@nasa.gov

Martha Maiden, NASA Headquarters, martha.e.maiden@nasa.gov

Michael Goodman, NASA Marshall Space Flight Center, michael.goodman@nasa.gov

The Land Atmospheres Near-real-time Capability for EOS (LANCE) system [hosted by NASA's Earth Science and Data Information System (ESDIS)] provides a wide variety of near-real-time data products from the Aqua, Terra, and Aura spacecraft to the applications user community. The LANCE Level 1 (L1) and L2 applications data products are available for distribution within three hours of observation, in contrast to the standard science-quality products that are available within 8–40 hours of observation. To facilitate faster data availability, the system uses predicted attitude and ephemeris data and the algorithm codes used in LANCE include less-restrictive rules for the use of the ancillary data products. As a consequence, in some cases there are minor differences between the standard products and the near-real-time data products. Science and near-real-time product comparisons are available from lance.nasa.gov; user services can provide additional information. **Table 1** shows the instruments from which products are presently generated by LANCE, along with a list of the broad product categories available.

The goal of LANCE is to provide near-real-time data to NASA's various of *end users*—who range from scientists to operational agencies. NASA's Applied Sciences Program has supported the development of some near-real-time applications that help to discover and demonstrate

innovative uses and practical benefits of NASA Earth science data, scientific knowledge, and technology.

At the first LANCE Workshop held in December 2009 at the University of Maryland¹, representative users were invited to provide valuable guidance that has influenced the evolution of LANCE and its elements since that time. A key recommendation from that workshop requested a governance model containing mechanisms for future system evolution, as well as vetting proposed new requirements. As a result, a User Working Group (UWG) composed of a representative section of active LANCE users from application developers and operational agencies to universities and Non-Government Organizations (NGOs) was convened. This group provides advice and helps steer future development of the LANCE Program.

ESDIS hosted the first LANCE UWG meeting at the University of Maryland in November 2010. In addition to the UWG members, 20 other individuals attended representing NASA HQ, ESDIS, the LANCE elements and other data providers, and other members of the

¹ The meeting summary for the first LANCE Workshop is in the March-April 2010 issue of *The Earth Observer* [Volume 22, Issue 2, pp. 18–20].

Table 1. Instruments [Mission(s)] with data products currently available through LANCE

Instrument ² [Mission(s)]	Product Category
AIRS [Aqua]	Radiances, temperature and moisture profiles, clouds and trace gases
MLS [Aura]	Ozone and temperature
MODIS [Aqua and Terra]	Radiances, clouds/aerosols, water vapor, fires, snow, sea ice, land surface reflectance, and land surface temperature
OMI [Aura]	Ozone, sulfur dioxide, aerosols, cloud top pressure
AMSR-E [Aqua]	Brightness temperature, soil moisture, rain rate, ocean products, snow water equivalent, and sea ice

²AIRS—Atmospheric Infrared Sounder; MLS—Microwave Limb Sounder; MODIS—Moderate Resolution Imaging Spectroradiometer; OMI—Ozone Monitoring Instrument; AMSR-E—Advanced Microwave Scanning Radiometer – EOS.

user community. The purposes of the two-day meeting were to:

- review the existing LANCE system and identify ways in which the services may be improved;
- solicit suggestions for future additions and upgrades to LANCE; and
- provide a forum for discussion of potential system changes and solicit UWG feedback.

The first day of the meeting consisted of presentations by representatives from NASA HQ, ESDIS staff, UWG members, LANCE element staff, and representatives of the user community with specific suggestions for LANCE upgrades. The second day was dedicated to a discussion of the candidate system changes and upgrades, and a determination of which of these would be endorsed by the UWG.

Martha Maiden [NASA HQ] opened the meeting and identified its scope and objectives. **Dawn Lowe** [ESDIS] presented the ESDIS project management plans for LANCE and delineated the responsibilities of ESDIS and the individual LANCE data production elements. The LANCE products are freely available following registration. At present, there are in excess of 500 registered users from U.S. civilian and military government agencies, foreign government agencies, universities, and private sector organizations. In excess of 1 *terabyte* (TB) of data products are distributed by LANCE every day. A wide variety of applications areas are supported, including hurricanes, volcanoes, floods, fires, oil spills, dust storms, air quality, snow and ice, and weather.

Kevin Murphy [ESDIS] summarized recent LANCE progress. A LANCE website has been established to provide a common interface for the end users. It includes access to the products and services of the individual elements (*lance.nasa.gov*). The website provides information on LANCE, including registration, data access, products lists, and metrics.

A registration and authentication system has been established that allows a determination of the data distribution by user and permits the elements to provide announcements to the user community, e.g., when new products and services are added and to identify system problems and issues. A variety of post-processing tools have been provided for LANCE Moderate Resolution Imaging Spectroradiometer (MODIS), including parameter, band, and geographic subsetting, reprojection, mosaicing, and products in the GeoTiff format. The initial complement of Ozone Monitoring Instrument (OMI) products has been expanded to include sulfur dioxide (L2) and gridded column ozone (L3).

Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E) products—including L3 daily land, ocean, sea ice, and snow products—are now available. Atmospheric Infrared Sounder (AIRS) L1A products are also available in the Binary Universal Form for the Representation of meteorological data (BUFR) format. AIRS products are available through a web mapping service in PNG, GeoTiff, and KMZ formats.

Chris Justice [University of Maryland—*LANCE UWG Co-Chair*] presented the roles of the UWG, which represents the LANCE user communities and includes members who are familiar with both the applications and the science aspects of the data products. The UWG is charged with: 1) providing guidance on LANCE priorities and long-term goals; 2) assessing the quality of the products and services provided by LANCE and the progress made by the elements against prior UWG recommendations; and 3) developing a prioritized list of recommendations for LANCE development and system changes for the 12 months following the UWG meeting.

Nine members of the UWG gave presentations on their applications areas, including the U.S. Forest Service (USFS) Remote Sensing Applications Center (RSAC), the Dartmouth Flood Observatory (DFO), and the United States Agency for International Development (USAID) Famine Early Warning Systems Network and their use of LANCE data. All of the presentations are included on the LANCE website. A number of members discussed the latency requirements and relationship between LANCE and EOS Direct Readout data.

The EOS Data and Operations System (EDOS), the AMSR-E Science Investigator-led Processing System (SIPS), the Goddard Earth Sciences Data and Information Services Center (GES DISC), the OMI SIPS, and the MODIS Adaptive Processing System (MODAPS) all gave status updates. The presentations by the LANCE elements focused on the changes made to the system since the December 2009 workshop (summarized above), ongoing developments, and user-suggested upgrades. The EDOS provides the L0 and the attitude and ephemeris data to the LANCE elements.

Bruce McLemore [EDOS] described the EDOS architecture and the timeline for providing products to the LANCE elements. McLemore described the plans for three specific system changes designed to reduce LANCE latency that include: 1) removal of the Reed-Solomon decoding bits prior to network transfer—with an anticipated latency reduction of two minutes; 2) addition of lossless data compression following data receipt at EDOS—with an anticipated latency reduction of two minutes; and 3) inclusion of a L0 processing and distribution capability at White Sands to replace the Goddard Space Flight Center (GSFC)/EDOS func-

tion—with an anticipated latency savings (Terra only) of 15-20 minutes.

Helen Conover [University of Alabama at Huntsville] described recent developments with the LANCE-AMSR-E element. This included the installation of a new L2A algorithm and the addition of pixel-by-pixel comparisons of the standard and the near-real-time data products. The suggested system upgrades included generation of LANCE-AMSR-E products in the BUFR format, addition of incremental L3 products, addition of a geographic subsetting capability, addition of browse products, and use of the LANCE-MODIS Rapid Response system for displaying AMSR-E products.

Bruce Vollmer [GES DISC] discussed the LANCE-AIRS and LANCE-Microwave Limb Sounder (MLS) elements. Proposed system upgrades included installation of new and improved MLS algorithms, addition of an MLS water vapor product, provision of data access through the Open-source Project for a Network Data Access Protocol (OPeNDAP) (disc.sci.gsfc.nasa.gov/AIRS/data-holdings/by-access-method) and Giovanni (disc.sci.gsfc.nasa.gov/giovanni), and addition of geographic subsetting and products in the netCDF format.

Curt Tilmes [OMI SIPs] discussed the LANCE-OMI element. Ongoing developments included installation of a redundant system, and addition of three new L3 products. Proposed system upgrades included generation of data products in netCDF and GeoTiff formats.

Michael Teague [MODAPS] discussed the LANCE-MODIS element. Ongoing developments included installation of a redundant system, incorporation of the MODIS Collection 6 (C6) algorithms, and generation of both C6 and C5 products through Q2 of FY12, completion of the transition of the MODIS Rapid Response and Fire Information for Resource Management Systems (FIRMS) into LANCE-MODIS, and addition of a web mapping service and a web coverage service. Suggested system upgrades included use of Direct Broadcast in LANCE-MODIS, generation of global flood maps, and generation of a Naval Research Laboratory (NRL) assimilation product. Representatives of three user communities presented proposed upgrades to LANCE-MODIS.

Fritz Policelli [GSFC] described the generation of flood maps by the DFO. At present, the LANCE-MODIS subsetting land surface reflectance products are generated for a small number of tiles; the flood maps are generated manually. The thrust of this presentation was the proposal that LANCE-MODIS should generate and distribute global flood maps using the DFO flood-extent algorithm. The ensuing discussion concerned peer review of this nonstandard MODIS product algorithm, current levels of NASA Applications support for

this activity, and the desirability of an operational partner to support this important product.

Kim Richardson [NRL] discussed the six-hour aerosol assimilation product (filtered, gridded aerosol optical depth with error estimation) generated for the U.S. Navy using the LANCE-MODIS L2 aerosol and geolocation products. It was pointed out that the product had been developed in concert with the MODIS Aerosol Team. Since NRL is not constituted for such data production and distribution, it was suggested that LANCE-MODIS should be upgraded to generate the product.

Bruce Davis [Department of Homeland Security (DHS)/Federal Emergency Management Agency (FEMA)] discussed FEMA requirements for LANCE-MODIS data products. Given the nature of disaster response, it would be very desirable if data products were made available based upon data from MODIS Direct Broadcast stations.

Chris Justice and **Michael Goodman** led an extensive discussion of all proposed modifications and updates. The discussion focused on whether image visualization and analysis tools should be incorporated into LANCE and how such external services could be linked. ES-Dis was asked to develop a short *white paper* on how to address this issue. The relationship between Direct Readout and LANCE data was also discussed. There are a large number of Direct Readout stations around the world in various stages of development and operation. These stations downlink EOS data and generate products that can be generated within 20 minutes of acquisition. The NASA Direct Readout Laboratory (DRL) (directreadout.sci.gsfc.nasa.gov/), managed by Pat Coronado [GSFC], provides facilitation and coordination of these stations. Some of these ground stations use DRL-provided algorithms while others generate regional products using their own algorithms. A large number of stations make their data available to users. Some initiatives are underway to coordinate between ground stations on products of common interest, e.g., land-directreadout.org/. Although the group recognized that improved latency was important for some time-critical applications, the task of coordinating a global data initiative, setting up agreements, and managing ingest of L1 data from the various stations was deemed to be beyond the current scope of the LANCE program. Users are encouraged to contact ground stations providers with coverage of their regions of interest directly.

The UWG also discussed the desirability of a LANCE User Symposium in the coming year, to provide visibility to EOS near-real-time data users, and a forum for exchange of experience and feedback on LANCE capabilities from the broader user community. **Table 2** identifies activities endorsed by the UWG for FY11 with

associated levels of priority. These include a number of investigations, all of which will lead to study reports, and some of which will include prototyping efforts. The results of the prototyping investigations will be present-

ed at the next UWG for guidance on subsequent implementation. The UWG agreed to meet by teleconference to discuss these results as needed. ■

Table 2. LANCE activities funded for FY11 and priority assigned to each topic

UWG Action Topic	Description	Priority
Reduced Latency	Investigate the use of AMSR-E Direct Broadcast data and the provision of L1 and L2A algorithm codes to the Direct Readout Laboratory at GSFC	High
New/Enhanced Products	Investigate adding a rolling daily Nadir Bidirectional Reflectance Distribution Function (BRDF) adjusted Reflectance (NBAR) product to LANCE-MODIS	Medium
	Investigate generating incremental AMSR-E products to reduce the L3 latency	Low
	Extend the period for overlap of MODIS Collection 5 and 6 products	High
	Investigate adding other element products, e.g., AMSR-E rain rate data to Rapid Response	High
Data Access	Perform trade studies for LANCE data distribution techniques	Medium
	Perform trade studies for visualization techniques	Medium
	Complete the Web Mapping Service and the Web Coverage Service for LANCE-MODIS	High
Additional Tools	Investigate adding product formats such as BUFR, netCDF, and GeoTiff for all elements	Medium
	Investigate using standard tool sets (e.g., sub-setting) for all elements and investigate software re-use across elements	Low
LANCE Web Site	Investigate generating browse products for all LANCE elements	Low
	Add interactive area for users	Medium
	Add links for access to Direct Broadcast data	High
	Plan Near-Real Time Symposium to include data providers other than LANCE	Medium